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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)

09/242072

INTERNATIONAL APPLICATION NO.

PCT AU96 00442

INTERNATIONAL FILING DATE

5 August 1996

PRIORITY DATE CLAIMED

5 August 1996

TITLE OF INVENTION

"APPARATUS FOR LIQUID PURIFICATION"

APPLICANT(S) FOR DO/EO/US

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☐ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☐ Other items or information:

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)		INTERNATIONAL APPLICATION NO. PCT/US 96/00442		ATTORNEY'S DOCKET NUMBER	
17. <input type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1)-(5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1070.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$930.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$790.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$720.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$98.00 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS PTO USE ONLY	
				\$ 720.00	
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				\$	
				\$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	- 20 =	7	x \$22.00	\$	
Independent claims	- 3 =	4	x \$82.00	\$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable) ✓				+ \$270.00	
TOTAL OF ABOVE CALCULATIONS =				\$ 990.00	
Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28). ✓				\$	
SUBTOTAL =				\$ 495.00	
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Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +				\$	
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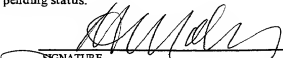
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NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:


 SIGNATURE
PETER A MILLER
 NAME

REGISTRATION NUMBER _____

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STATEMENT CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) & 1.27(c))—SMALL BUSINESS CONCERN

Docket Number (Optional)

Applicant, Patentee, or Identifier: PETER ANTHONY MILLER
 Application or Patent No.: PCT AUG6/00442
 Filed or Issued: 5 AUGUST 1996
 Title: "APPARATUS FOR LIQUID PURIFICATION"

I hereby state that I am

- ☐ the owner of the small business concern identified below;
☐ an official of the small business concern empowered to act on behalf of the concern identified below.

NAME OF SMALL BUSINESS CONCERN MILLER FILTER CO

ADDRESS OF SMALL BUSINESS CONCERN 3 SUNNINGDALE AV, GB-NEWCASTLE NE6 2DW

I hereby state that the above identified small business concern qualifies as a small business concern as defined in 13 CFR Part 121 for purposes of paying reduced fees to the United States Patent and Trademark Office, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time, or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby state that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention described in:

- ☒ the specification filed herewith with title as listed above.
☐ the application identified above.
☐ the patent identified above.

If the rights held by the above identified small business concern are not exclusive, each individual, concern, or organization having rights in the invention must file separate statements as to their status as small entities, and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e).

- ☒ Each person, concern, or organization having any rights in the invention is listed below.
☐ no such person, concern, or organization exists.
☐ each such person, concern, or organization is listed below.

Separate statements are required from each named person, concern or organization having rights to the invention stating their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

NAME OF PERSON SIGNING PETER ANTHONY MILLER

TITLE OF PERSON IF OTHER THAN OWNER

ADDRESS OF PERSON SIGNING 39 SIKNEY GATE, NEWCASTLE U TIME
GBRAT BRITAIN NE4 5PD

SIGNATURE [Signature]

DATE 28-JAN-1999

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APPARATUS FOR LIQUID PURIFICATION

Description

This invention concerns apparatus for the purification of liquids. By purification is meant the removal of unwanted suspended, colloidal or dissolved substances from a liquid.

The prior art of apparatus to achieve this consists of a large variety of generically related filters that utilize over-pressure and/or under pressure to provide the necessary pressure difference for filtration.

For the purification of liquids, filter presses or pressure leaf, candle and cartridge filters (pressure vessels containing such elements) are mainly utilized. Such liquids are chemicals, pharmaceutical products, beer, wine, sugar, oils and fats, petroleum products, etc. Their purification normally involves some form of "in-depth" filtration or purification process, whereby the liquid to be purified is either passed through or forms thereby a bed of particulate purification aid whereby the separation mechanism is mostly a combination of sieving-action and adsorption. The purification aids that are used include diatomaceous earth (kieselguhr), bleaching earth, ion-exchange resin, activated carbon, etc., all normally in powder form. The solid residues can rarely be regenerated and their disposal poses an acute environmental problem.

On the other hand, using apparatus of the nutsche-type filter in the form of open or closed containers, water is filtered by means of gravity or over-pressure on a large scale by means of thick, static beds of coarse granular material (e.g. sand). These beds are regenerated after filtration by backwashing techniques and reused. Although this method is suitable for the filtration of relatively clean surface and ground water, it is wholly unsatisfactory for the purification of industrial and domestic effluent. The reason is that the back-washing and regeneration techniques of prior art sand filters

- are inadequate for washing out most of the large variety of suspended solids contained in industrial liquid effluent

and

- produce excessive amounts of contaminated backwash liquid.

Added to this, the static nature of the beds is unsuited for the filtration of particulate matter, as large sections of the bed remain unused and the necessity for utilizing relatively coarse granular material comprising the beds for removing organic and inorganic contaminants in solution precludes on economic grounds the possibility of utilizing the extensive range of available adsorbents comprising such materials as activated carbon, anthracite, ion-exchange resin, bleaching earth, molecular sieves, etc. required for removing specific contaminants in the field of effluent and water purification.

The goal of this invention is to further develop the art and science of "in-depth" filtration utilizing beds of loose material for the purification of liquids such as processed by the

above named industries, whereby the beds are regenerated and reused more effectively than with prior art methods, resulting in a considerable reduction in the quantity of liquid and solid waste for disposal. Considering the present practice, in both the industrial and communal sector, of discharging effluent to the natural environment that is incompletely purified, the further goal is to provide these sectors with an effluent and water purification apparatus that will enable liquid effluent to be recycled and polluted water to be rendered suitable for domestic and industrial purposes.

It is proposed that the apparatus of the invention will be far more compact and versatile compared with the prior art in that it can be installed not only in large industrial and communal plants, but also in the medium to small size industrial sector. This will be achieved by utilizing specific through-puts 10-100 times those normally employed by prior art filters. Specific through-puts of 50-200 m³/m².h will be possible because the beds will be maintained in an "open" condition throughout the filtration and/or purification cycles. A further goal of the invention is to provide the liquid purification apparatus of the invention with the means for automatically selecting and applying varying types and grades of filter media and modes of operation according to the nature, filtration characteristics and requirements of any type of liquid purification operation, whereby no further distinction will be made between effluent, water and process liquid purification. The ultimate aim of the invention is to reduce the number of purification steps presently required for process liquid purification, whereby waste generation will be reduced and the purification media regenerated and reused, thus enhancing the competitiveness of these industries and simultaneously relieving the present impact on the environment. The aim of the invention with industries presently using liquids in their production processes for such operations as plating, dyeing, washing, coating, pickling, quenching, etc. is to provide the means for continuous regeneration to avoid the necessity for dumping into the environment.

THE INVENTION

Fig.1 is a schematic flow-sheet of the apparatus of the invention that consists of a purifying filter plant 1, comprising essentially a lower stationary filtrate chamber 2 with a porous upper surface on which a section of an intermittently movable filter belt 4 is supported which in operation is stationary and sealed at the periphery by vertically movable dependent rim portions 3 of an upper contaminant container 5 fitted with a conically perforated feed distributor 27 extending over the entire upper horizontal section, a bed regeneration apparatus 6, a bed material storage/dosing vessel 7, a filter aid suspension tank 11, one or more adsorbent storage/dosing devices 8, a reservoir for liquid to be purified 10 and a residue filter 9.

Filter aid suspended in liquid in tank 11 is dosed into the vented container 5. While the pressure difference between the container 5 and the lower filtrate chamber 2 is raised, liquid to be purified in reservoir 10, which may be dosed with flocculating

substances such as polyelectrolytes, is pumped using means 22 from reservoir 10 into container 5. Simultaneously, suspensions of bed material recycled from regenerator 6 and activated powdered adsorbents are dosed using means 7/20 & 8/19 under pressure to a mixing section 27 of the delivery conduit 12 controlled by microprocessor 15 from input data from instrumentation 14 and 13 in the delivery conduit 12 and the filtrate conduit 16 respectively. The liquid quality and process parameters (concentration) controlled include turbidity, pH, hardness, chlorinated organics, mineral oil, heavy metals, phosphates, nitrates, etc. as well as variables such as pressure difference and through-put. Filtrate is recycled, if necessary by means of a suction/vacuum pump (28), through conduits 16 & 17 to reservoir 10 until the concentration of contaminants in the filtrate is reduced to a set level as measured at 13. Filtrate flow is switched to conduit 18 whence it is collected in a reservoir not shown. On either reaching a pre-set pressure differential across the bed or a pre-set upper level of contaminant concentration as measured by instrumentation 13, pump 22 and all dosing apparatus are shut down and external gas is fed through conduit 23 to container 5 whereby the residual liquid in the chamber and bed is removed, after which the dependent rim portions 3 of container 5 are raised and the bed is transported by the filter belt 4 and discharged into the bed regenerator 6. The dependent rim portions 3 are lowered onto a fresh section of belt and the cycle described above is repeated. The regenerator 6, in effect, removes adsorbate and entrapped particulate matter (ultrasonics, turbulence, diffusion, etc.) from the internal and external surfaces of the granular material, which may be an adsorbent itself, thereby regenerating, cleaning and restoring the desired activities to these surfaces. Clean liquid is introduced to 6 through conduit 24 and by means of hydraulic classification action the adsorbate and particulate matter are removed through conduit 25 to filter 9 to recover a solid waste. Depending on its nature, the recovered fluid is recycled to 10 or reprocessed. Not shown are the means for introducing and removing the bed regenerating and reactivating fluids to and from bed regenerator 6. Fig.2 is a schematic representation of a partly sectioned elevation of media feeding mechanisms of the invention. Prior art filters have the disadvantage that a replacement of filter media involves lengthy shut-down periods and often excessive manual manipulation. A further goal, therefore, of the present invention is to provide the means for automatically and quickly fitting a large variety of prefabricated materials (e.g. membranes, paper, carton, etc.) to fulfill the requirements of the liquid processing industries. Pressure cylinders 215, normally taking the form of hydraulic or pneumatic rams are provided for actuating the dependent rim portions 3 of the filter container 5 in the vertical direction for bed removal and container closure.

A plurality of rolls of filter media 209, 210 are provided for feeding sections onto the lower filtrate chamber 2. Drive rollers 220, 221 located on the surface of the media rolls and actuated by a brake/clutch mechanism 225 driven by the filter belt 217 through idle

rollers 207, feed lengths of filter band over guides 223 into the rollers 207 onto the surface of the moving filter belt 217. Belt sensor 218 shuts down the belt drive motor 216 and actuates the band slitting mechanism 208 after which the section of filter medium and the supporting filter belt are finally positioned in the container 5 and the depending rim portions of the container are lowered to seal the periphery of said sections. After filtration the used sections of filter medium are normally transported out of the container 1 for disposal.

Cassettes 212, located externally to the filter container 1, are designed to feed pre-cut, pre-fabricated sheets of various types of filter media such as membranes, paper, carton, etc. into the filter container for filtration. Individual sheets are taken from the top of spring-loaded bundles 223 by means of actuated rubberized rollers 213 and fed on guides 224 to synchronously driven feeder belts 214, whereby after positioning on the porous upper surface of the filtrate chamber 2, the dependent rim portions 3 of the container 5 are lowered to seal both the belt and the overlying section of filter medium. After the filtration operation the material is transported out of the container 1 for disposal.

Fig.3 is a sectioned drawing showing an improved method for ensuring that the dependent rims 3 when they take the form of peripheral, integral sides of the container 5 are actuated in the horizontal orientation when raised and lowered and that the full thrust of the fluid driven pistons in cylinders 215 is exerted when sealing the container 5 against the horizontal pervious base 2. The bodies of the cylinders 305 are fixed to an external load-bearing framework 306 with the external extremity of the lubricated shafts 307 connected to the lower ends of vertically sectioned cylindrical sleeves 301 extending and fixed at the top end to transverse beams 308 that in turn actuate thrust shafts 303 acting directly through seals onto the top peripheral part of the container 5. Annular sections of guiding plastic material 302, preferably out of polytetrafluorethylene, are fixed to the surface of the cylinders fitting into the space between the surface of the cylinders and the inner surface of the reciprocating sleeves 302.

Fig.4 is a schematic representation of apparatus of the invention for:

- automatic selection of filter media;
- automatic selection of the optimal mode of filtration or purification;
- automatic measurement of the permeability of sections of filter media;
- automatic regeneration of partially 'blinded' sections of filter media.

A typical procedure according to the invention for the filtration or purification of a quantity of liquid of unknown filtration characteristics is the following:

A liquid is to be clarified, whereby the filtrate in the filter residue (cake) is to be

recovered by a washing operation. The required degree of clarification in units of turbidity is known. This and other pertinent information are entered into the programmed microprocessor 15 and the following sequence of operations proceeds fully automatically:
Start:

1. A section of 10 micron retention filter paper from 212 is automatically fed into the filter container.
2. The dependent rim portions of the container 5 are lowered to seal the section of paper lying on the filtrate chamber.
3. The differential pressure controller 404 establishes a preset pressure differential between the chamber sealing space 402 and the filtrate chamber 403.
4. With the container 1 vented, approx. 15 l/m^2 of the suspension are introduced to the top container 5 and distributed over the surface of the sealed section of filter paper.
5. Compressed gas is introduced to the top chamber through control valve 407, whereby the gas pressure and flow controllers 405/6 control and indirectly establish the filtration characteristics of the suspension by measuring the volumetric flow of gas in the top container 5. A sample of filtrate flows through a turbidity meter 410 to record the degree of clarity of the filtrate.

.....
The computer 15 chooses the filtration mode and type of medium:

Mode: precoat with medium speed diatomite with 1% body-feed

Medium: 20 micron polyestermonofil section of belt
.....

6. The depending rim portions (3) are raised and the filter paper is discharged.
7. The 20 micron belt section is automatically positioned in the container 1.
8. Steps 3,4,5 are repeated with a liquid of known filtration characteristics.
- 9a. Result of permeability test: negative. The section of belt is subjected to a standard cleaning/regeneration procedure after which steps 3,4,5 are repeated.
- 9b. Result: positive. With the container 1 vented, approx. 20 l/m^2 of diatomite suspension are introduced to the top container 5.
10. While the chamber 5 is being pressurized with gas, suspension to be filtered with 1% diatomite body-feed is introduced under pressure through valve 407. The feed rate is controlled by a pressure differential controller 405. Filtration proceeds.
11. On reaching a preset pressure differential, filtration terminates. Valve 401 shuts.
12. Valve 407 opens. Gas forces rest suspension through the filter cake.
13. Gas flow controller 406 signals a break-through of gas through the filter cake.
14. Valve 407 shuts.
15. The valve 408 opens. A pre-set quantity of wash liquid is fed to the container 5.
16. Valve 408 shuts. Valve 407 opens. Gas forces wash liquid through the cake.

17. The flow controller 406 signals a break-through of gas through the filter cake.
18. Cake drying.
19. The valve 407 shuts. Container is vented by opening 411. Container opens.
20. Belt transport. Cake discharge.
21. Belt wash (belt wash liquid is used for subsequent cake wash operation).
22. 20 micron belt section relocated in the container 1.

-cycle repeated-

Fig.5 & 6 show a schematic representation of an innovative filtrate chamber 2 whereby the fixed pervious bed of the prior art is replaced by manually removable pervious elements 502 to facilitate the cleaning and/or sterilization of the internal surfaces and drainage members 504. According to the invention only planar, smooth surfaces of the floor of the filtrate chamber remain after the manual removal of the elements. In a preferred design, the filtrate chamber consists of a hollowed-out plate 505 with smooth polished upper surfaces on which the removable elements, preferably consisting of expanded sheets or layers of woven mesh of metal or plastics that are covered and integral with flat perforated sheet, mesh or profiled grid material. To accommodate the high liquid throughputs of the invention and to minimize the bulk and cost of the elements, generously proportioned multiple filtrate outlet conduits 506 are provided, preferably coinciding with the intervals of the fluid driven cylinders 215, whereby the conduits are made integral with the supporting framework and designed to support the filtrate chamber as well as to withstand the thrust of the closure of the upper container. These conduits are also designed for ease of access and cleaning.

Fig.7 shows a schematic drawing, wherein the filter web takes the form of a belt that is driven by a motor or actuator 702 to reverse the direction of transport of the belt to enable the discharge of the filter bed or filter cake at either end of the purifying apparatus 1. One of the major advantages of this configuration is that the permanent attachment of a bed regenerator 6 and a filter cake receiver at either end can be achieved.

The above described invention effectively bridges the gap between prior art sand (in-depth) and pressure filters presently employed in the liquid processing industries. The implications are that both liquid processing and using industries can be rationalized and improved to increase their competitiveness and simultaneously reduce considerably the present negative impact on the environment.

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Claims

1. Liquid filtering apparatus in the form of an open or closed vessel containing deep, static beds of coarse granular material such as sand acting as filter medium supported on a porous floor that divides the vessel into an upper turbid liquid chamber with an inlet nozzle or connection and an upper outlet or connection for the removal of bed backwashing liquid and a lower filtrate chamber with a backwashing liquid inlet nozzle and a filtrate outlet nozzle, whereby in operation to remove suspended solids the turbid liquid is preferably passed from top to bottom through the bed after which, and before repeating the cycle, clean liquid such as filtrate is passed through the bed from bottom to top to remove the solids trapped in the bed which leave the container as a suspension through a top outlet nozzle or connection, *thereby characterized*, that the container (1) with an upper turbid liquid feed conduit (12) and a lower filtrate outlet conduit (16) is divided in the vicinity of the level of the pervious horizontal base (2) in such a way that a dependent rim portion(s) (3) of the upper turbid liquid chamber (5) is movable to facilitate the discharge of the bed from the container.

2. Liquid filtering apparatus according to Claim 1, *thereby characterized*, that means are provided to discharge the bed to a bed regeneration device (6), where the bed material is cleaned or cleaned and reactivated and recycled to the turbid liquid chamber (5) of the filtering apparatus (1) for reuse.

3. Liquid filtering apparatus according to Claim 1, *thereby characterized*, that means are provided to discharge the bed to a bed regeneration device (6), where the material of the bed is cleaned or cleaned and reactivated and thence recycled to a dosing device (7/20) and thence to the turbid liquid chamber (5) of the filtering apparatus (1) for reuse.

4. Liquid filtering apparatus according to Claim 1, *thereby characterized*, that means are provided to discharge the bed to a bed regeneration device (6), where the material of the bed is cleaned or cleaned and reactivated and thence recycled to the dosing device (7/20) and thence dosed to the turbid liquid chamber (5) of the filtering apparatus (1) during the filtration operation, whereby the depth of the bed increases incrementally during the operation.

5. Liquid purifying apparatus and method according to Claims 1-4, *thereby characterized*, that the cleaned or cleaned and reactivated bed before being recycled to the turbid liquid chamber (5) for reuse is mixed with active powdered material such as bleaching earth, ion-exchange resins, activated carbon, etc.

6. Liquid purifying apparatus and method according to Claim 5, *thereby characterized*, that a dosing apparatus (8/19) is employed to dose the active powdered material to the granular material of the bed either before or during the purification operation when the depth of the bed increases incrementally.

7. Liquid filtering and purifying method according to Claims 5, 6, *thereby characterized*, that means are provided to treat the surface of the powdered active material with a surface activating medium to enhance its adhesion to the activated surface of the granular material comprising the bed.

8. Liquid filtering and purifying method according to Claims 1-7, *thereby characterized*, that the liquid to be filtered and/or purified in reservoir (10) is dosed with flocculating substances such as polyelectrolytes before or during the filtration and purifying operation.

9. Liquid filtering apparatus according to Claim 1, *thereby characterized*, that means are provided in the form of a conically perforated distributor (27) that extends over the entire internal cross-section of the turbid liquid chamber (5).

10. Liquid filtering apparatus consisting of

- a section of web of filter medium lying on and supported by a porous support surface;
- cover means with dependent rim section(s) extending downwards, the lower surfaces of which make direct sealing engagement with peripheral portions of the said section of web of filter medium, thus forming an upper turbid liquid chamber;
- a receptacle for filtered liquid located beneath the porous support surface having upstanding rim portions, the upper surfaces of which make sealing engagement with the lower peripheral portions of the section of web of filter medium forming a lower filtrate chamber;

- means for engaging and disengaging the said lower and upper and surfaces of the said upper cover and lower receptacle, thus sealing and releasing respectively the said portions of the filter web;
- conduit means in fluid communication with a source of turbid liquid *and* gas and the interior of the cover means;
- conduit means for removing filtrate from the receptacle for filtered liquid;
- means for interrupting or initiating the flow of liquid or gas in the said conduits;
- means to control the filtration operation consisting of a throttling valve located in the said turbid liquid conduit controlled by a device measuring the differential pressure between the turbid liquid chamber and the receptacle for filtered liquid, as well as means in the form of a gas flow controller, a gas throttling valve and a gas pressure controller in series in the said gas conduit controlling the throughput of filtrate to the receptacle for filtered liquid;
- means to transport filter residue consisting of a web of filter medium in the form of a band,
whereby the band consists of a plurality of sections (201/2/3) providing different degrees of filtrate quality or consisting of different materials;

11. Liquid filtering apparatus according to Claim 10, *whereby* the band consisting of a plurality of sections is provided with the means (204/5/6) for individually removing and replacing each section.

12. Liquid filtering apparatus according to Claim 10, *whereby* sections of the band are used as support for strips of prefabricated filter media from storage means either pre-cut or cut "in-situ" to appropriate length and then introduced to the interior of the turbid liquid chamber (5) to coincide with the pervious horizontal base (2) and sealed at the periphery (402) by the dependent rim portion(s) (3) of the said chamber.

13. Method of liquid purification according to Claim 1, *thereby characterized*, that as support for the bed of granular material a layer of finely powdered filter aid is first of all formed on the section of filter medium in the turbid liquid chamber (5).

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14. Liquid purifying apparatus according to Claims 4/6, *thereby characterized*, that the dosing devices are controlled by a microprocessor (15) from input signals from feed and filtrate instrumentation (13,14).

15. Apparatus and method of filtration control according to the defining preamble of Claim 10, *whereby* means to control the filtration operation consist of a gas flow controller, a gas throttling valve and a gas pressure controller connected in series from a source of compressed gas to the turbid liquid chamber (5) , *thereby characterized*, that the said means are employed to measure the *permeability* of any filter media before or during any liquid filtration or purification operation by introducing and filtering a volume of liquid of *known* quality to the turbid liquid chamber.

16. Apparatus and method of liquid purification control according to Claim 15, *thereby characterized*, that the *quality* of the turbid liquid and filtrate are determined by instrumentation such as (13/14), whereby optionally the data is fed to a microprocessor/process controller (15) to choose and implement the supply of the optional filter medium before or during any liquid purification operation.

17. Apparatus and method of liquid purification control according to Claims 11 - 16, *thereby characterized*, that the optimal *mode* of purification such as direct filtration by textiles, membranes, non-woven material, precoat filtration, deep-bed purification with or without active powdered material, etc. is determined before or during any liquid purification operation.

18. Apparatus according to the defining preamble of Claim 10, *whereby* the means for engaging and disengaging the upper and lower surfaces of the upper cover and lower receptacle consist of laterally positioned fluid driven pistons (304) contained in cylinders (305), the bodies of which are fixed to a load-bearing framework with the

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external extremity of the lubricated shafts (307) connected to sectioned sleeves (301) extending and fixed to the extremities of transverse beams (308) acting on the peripheral part of the upper container (5), *whereby* to ensure movement of the dependent rim portion(s) in the horizontal position, sections of material such as polytetrafluorethylene (302) are fixed to the surfaces of the bodies of the fluid driven cylinders (305) fitted in the space between the cylinder surfaces and the internal surfaces of the reciprocating sleeves (301).

19. Apparatus according to the defining preamble of Claim 10, *whereby* the receptacle for filtered liquid located beneath the porous support surface consists of a recessed plate (505) containing one or a plurality of manually removable medium supporting drainage members (502) preferably consisting of an upper perforated sheet (503) lying flush with the peripheral sealing portions of the plate (505) and integrated with a lower layer or layers of material such as woven mesh or expanded metal sheet (504).

20. Apparatus according to the defining preamble of Claim 10, *whereby* the means for transporting the filter residue in the form of a band is driven by a motor or actuator (702) provided with the facility for reversing the direction of transport of the band to discharge the filter bed or residue at either end of the purifying apparatus.

ABSTRACT

The invention concerns a liquid purifying apparatus that bridges the gap between prior art sand filters as applied mainly in the field of water treatment and pressure leaf, candle and cartridge filters as well as filter presses for filtration and purification in the liquid processing industries. In contrast to prior art sand filters where static beds of granular material are regenerated by backwashing techniques, the granular beds of the present invention are transported out of the filter container by a moving filter belt into an external bed-regenerating device after which the regenerated and reactivated bed is reused by dosing to the filter container with the incoming fluid to be purified. It is proposed to simultaneously dose a variety of active powdered adsorbents, such as activated carbon, molecular sieves, etc., to the purifier influent to remove specific dissolved contaminants, whereby the surface charge and particle size of this material are designed to adhere to the surface of the particulate matter of the bed. The dosing of active adsorbents and the particulate matter of the bed is controlled by a programmed microprocessor receiving input process data from influent and effluent instrumentation. A further feature is the provision of apparatus for feeding prefabricated sections of filter media such as membranes, non-woven and woven materials into the filter container for application in fully automatic operation throughout the whole spectrum of industrial and communal liquid purification processes.

The diagram illustrates a vacuum furnace system. A central furnace chamber (1) contains a sample (2) on a support (3). The chamber is surrounded by a cooling jacket (4) and a vacuum insulation layer (5). The chamber is connected to a vacuum pump (6) via a valve (7) and a pipe (8). The pump is connected to a vacuum gauge (9) and a vacuum switch (10). The furnace is connected to a power supply (11) via a valve (12) and a pipe (13). The power supply is connected to a vacuum gauge (14) and a vacuum switch (15). The furnace is also connected to a control system (16) via a pipe (17). The control system includes a vacuum gauge (18) and a vacuum switch (19). The furnace is connected to a cooling system (20) via a pipe (21) and a valve (22). The cooling system is connected to a vacuum gauge (23) and a vacuum switch (24). The furnace is connected to a heating system (25) via a pipe (26) and a valve (27). The heating system is connected to a vacuum gauge (28) and a vacuum switch (29).

Fig.1

-3/5-

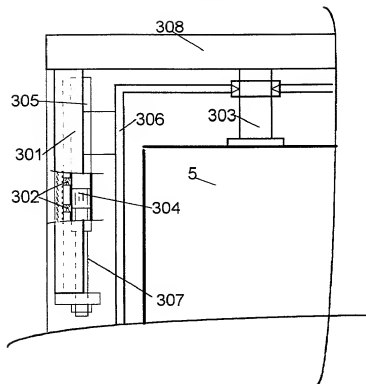


Fig.3

-4/5-

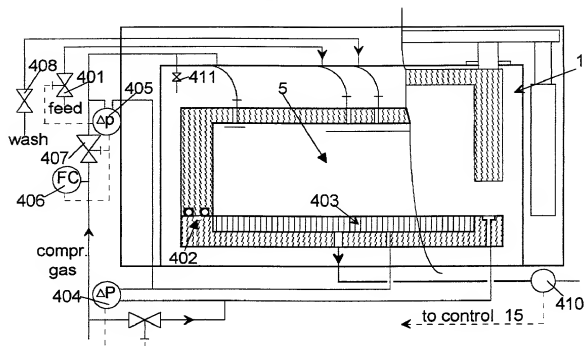


Fig.4

-5/5-

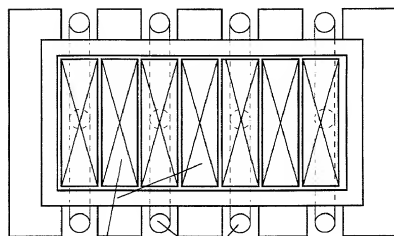


Fig. 5

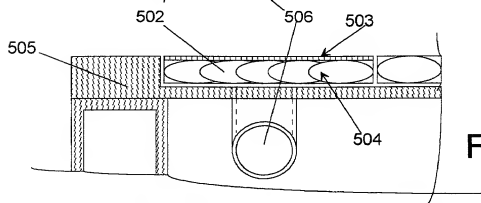


Fig. 6

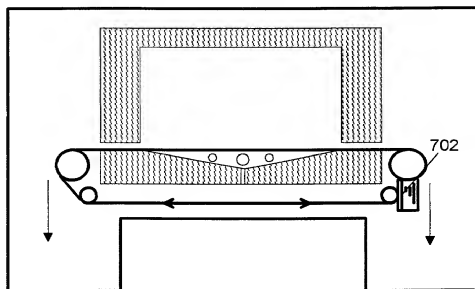


Fig. 7

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration
Submitted
with Initial
Filing

OR

☐ Declaration
Submitted after Initial
Filing (surcharge
(37 CFR 1.16 (e))
required)

Attorney Docket Number

--

First Named Inventor

Peter A Miller

COMPLETE IF KNOWN

Application Number

PCT /AU96/00442

Filing Date

05AUG96

Group Art Unit

Examiner Name

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

"APPARATUS FOR LIQUID PURIFICATION"

the specification of which

(Title of the invention)

☐ is attached hereto

OR

☐ was filed on (MM/DD/YYYY)

05AUG96

as United States Application Number or PCT International

Application Number PCT/AU/00442 and was amended on (MM/DD/YYYY) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?	
19534102.3 -27	Germany	14SEPT95	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	YES <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	NO <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>

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I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(e) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)
PCT/AU96/00441	05AUG96	

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Place Customer Number Bar Code Label here

Name	Registration Number	Name	Registration Number
(inventor and applicant to prosecute application)			

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☐ Customer Number or Bar Code Label OR ☐ Correspondence address below

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Address	See Str.27, D-71229 LEONBERG		
Address			
City	LEONBERG	State	
Country	GERMANY	ZIP	
Telephone	0044 7152 902234	Fax	ditto

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor:		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
Given Name (first and middle (if any))		Family Name or Surname	
Peter Anthony		MILLER	
Inventor's Signature			Date 20.12.99
Residence: City	Leonberg	Country	GERMANY
Post Office Address	See Str.27 D-71229 LEONBERG		
Post Office Address			
City		State	
		ZIP	
		Country	

☐ Additional inventors are being named on the supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto.

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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page ___ of ___

Name of Additional Joint Inventor, if any:

☐ A petition has been filed for this unsigned inventor.

Given Name (first and middle (if any))

Family Name or Surname

Inventor's
Signature

Date

Residence: City

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Name of Additional Joint Inventor, if any:

☐ A petition has been filed for this unsigned inventor.

Given Name (first and middle (if any))

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Name of Additional Joint Inventor, if any:

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Given Name (first and middle (if any))

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				YES	NO
None			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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Additional provisional applications:

Application Number	Filing Date (MM/DD/YYYY)
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Additional U.S. applications:

U.S. Parent Application Number	PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)
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